

# First record of *Ceratium* Schrank, 1973 (Dinophyceae: Ceratiaceae) in freshwater ecosystems in the semiarid region of Brazil

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**ABSTRACT:** This paper reports the first record of the genus *Ceratium* Schrank, 1973 in six freshwater ecosystems in the semiarid region of Brazil. From 2006 to 2010, 1176 samples were collected from 98 different sites using conical-cylindrical plankton nets with a 25 µm mesh size. Twenty individuals from each sample were measured for the obtainment of the morphological measurements. A 25% NaClO solution was used for the clarification of the cells and visualization of the plates. The appearance of this genus in such ecosystems is likely related to climatic and hydrological changes in the region.

The genus *Ceratium* Schrank, 1973 pertains to the division Dinophyta, order Peridiniales, family Ceratiaceae. This genus has five freshwater species, which are free-swimming one-celled species that live a solitary existence (Hickel 1988; Popovský and Pfiester 1990). Their strong cell wall is made up of 16 or 17 cellulose plates, which may be smooth or strongly ornamented. The cells are asymmetric and quite flat dorsoventrally. The cell wall has two sulci – one transversal, which surrounds the cell, and the other perpendicular to the first. The first sulcus delimits the epitheca and hypotheca. The epitheca has only one horn, which is somewhat conical and elongated, whereas the antiapical region (hypotheca) has two or more horns, the development of which depends on variations in temperature (Popovský and Pfiester 1990).

The occurrence of the genus *Ceratium* was already registered in various freshwater ecosystems in the world, with records published for Hungary (Padisák 1985), Taiwan (Wu and Chou 1998), Australia (Whittington *et al.* 2000; Baldwin *et al.* 2003), Spain (Pérez-Martínez and Sánchez-Castillo 2001), USA, Canada and Japan (Carty 2003) and Argentina (Mac Donagh *et al.* 2005, 2009). In Brazil the occurrence is considered rare. Branco *et al.* (1963) report the first record of *Ceratium*. More recently, Ferrareze and Nogueira (2006) report the occurrence of *C. hirundinella* in the Paranapanema reservoir in southeastern Brazil; Santos-Wismiewski *et al.* (2007) recorded the presence of *Ceratium furcoides* in the Furnas reservoir in the state of Minas Gerais; and Matsumura-Tundisi *et al.* (2010) recorded *C. furcoides* at the Billings dam in the state of São Paulo.

In the present study, the *Ceratium* was recorded in six freshwater ecosystems in the semiarid region of northeastern Brazil: Sobradinho reservoir (09°35' S, 40°50' W), Contas river (12°55' S, 39°00' W), Moxotó river

(09°20' S, 038°13' W), Paulo Afonso reservoir (09°23' S, 38°12' W), Itaparica reservoir (08°47' S, 38°46' W) and Xingó reservoir (09°37' S, 37°47' W) (Figure 1). These sites are located in the states of Alagoas, Bahia, Pernambuco and Sergipe. The ecosystems studied are either the sites of hydroelectric plants (Sobradinho, Paulo Afonso, Itaparica, Xingó) or rivers with this type of construction somewhere along their extension, such as the Contas and Moxotó rivers.

From 2006 to 2010, 1176 samples were collected from 98 different sites. The samples were obtained from vertical trawls along the euphotic zone [determined by a digital quantometer (Licor-250)] using conical-cylindrical plankton nets with a 25 µm mesh size. The material was preserved in 4% acetic Lugol solution, subsequently examined under an optical microscope, photographed with the aid of a microscope (Zeiss/Axioskop) equipped with a camera (Samsung SCC833, Japan) and analyzed using the Imagelab program (Softium, Brazil). Twenty individuals from each sample were measured for the obtainment of the morphological measurements. A 25% NaClO solution was used for the clarification of the cells and visualization of the plates. Identification was based on Popovský and Pfiester (1990).

The ecosystems studied had a high concentration of phytoplankton (data not published), with the distribution of the species mainly among the classes Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae. However, representatives of other classes, such as Euglenophyceae, Dinophyceae and Cryptophyceae, were frequently recorded.

After three years of study, the first occurrence of *Ceratium* spp. was recorded in April 2009 in the Sobradinho reservoir (Figure 2). This ecosystem is located in the region known as the middle São Francisco. The

São Francisco river is an ecosystem that covers a large extension of territory and is subdivided into three regions: upper, middle and lower. In the ecosystems that make up the lower São Francisco, the occurrence of this genus was first recorded in December 2009. For the Contas river, the occurrence of this taxon was first recorded in July 2009.

These findings for the ecosystems that make up part of the São Francisco river system indicate that the invasion of

this genus followed the course of the river. The appearance of this genus in different ecosystems of the semiarid region of northeastern Brazil is likely related to climatic and hydrological changes.

Regarding the morphology of *Ceratium*, the populations studied (Table 1), suggesting that two species occurs in the different ecosystems, *C. furcoides* (Levander) Langhans and *C. cf. hirundinella* (O.F. Müller) Dujardim.

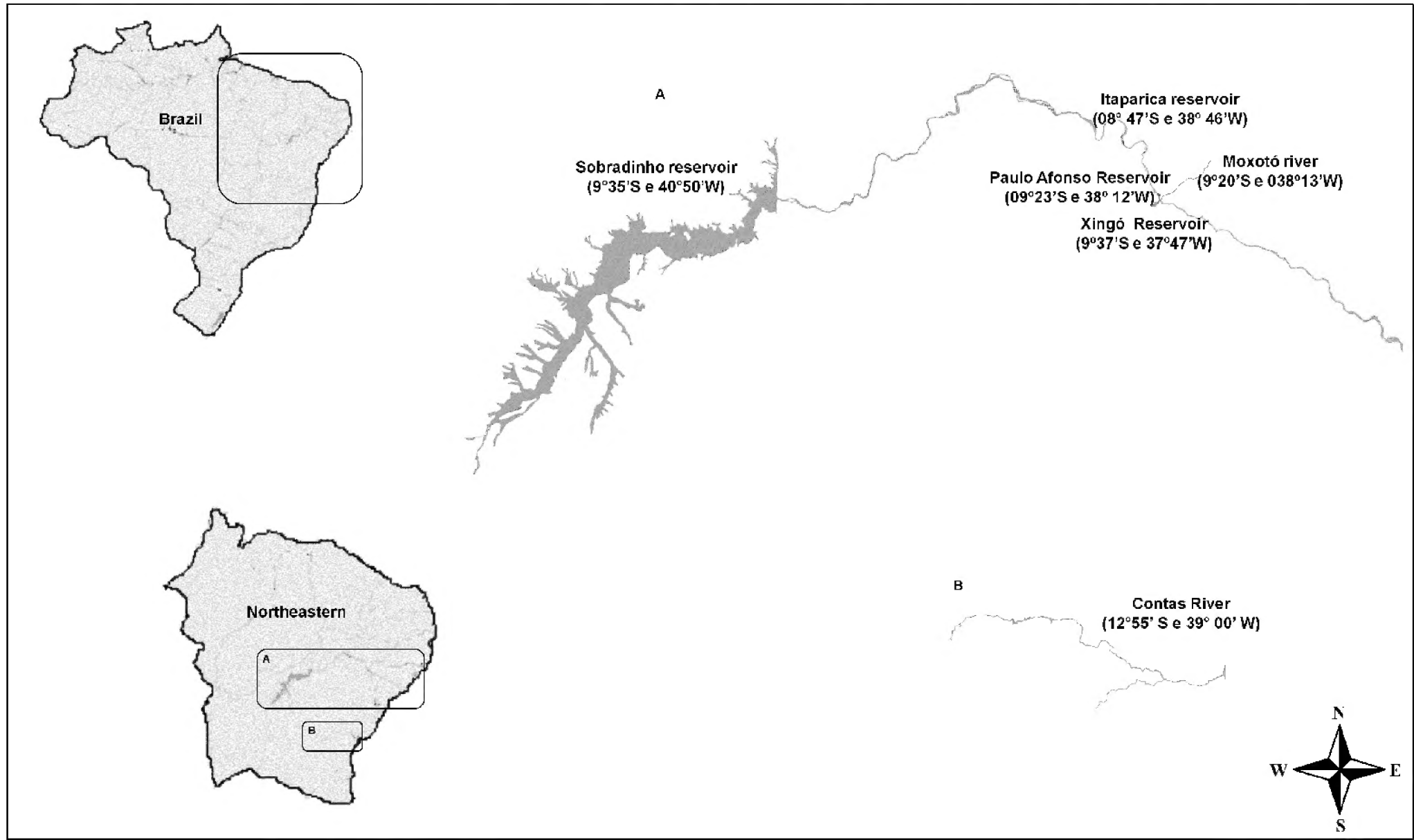


FIGURE 1. Map of freshwater ecosystems studied in semiarid region of Brazil.

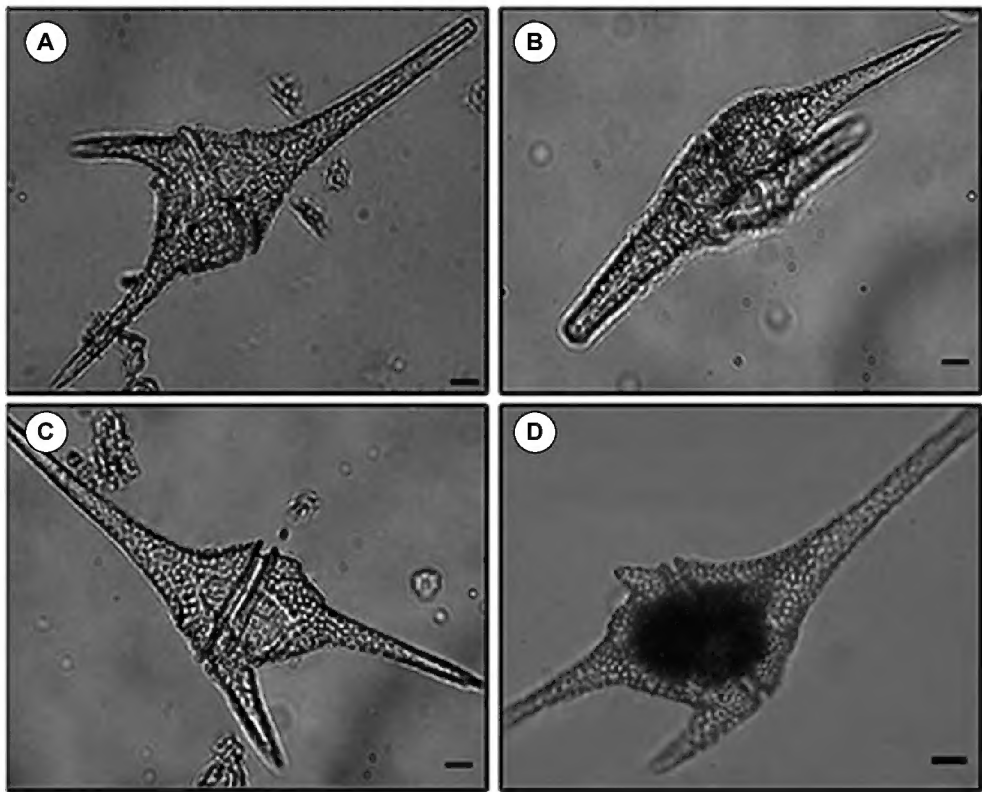


FIGURE 2. Representatives of *Ceratium* spp. in freshwater ecosystems in semiarid region of Brazil. a-c. *Ceratium furcoides*; a) Dorsal view; b) lateral view; c) ventral view; d) dorsal view of *C. cf. hirundinella*. Scale Bar: 10  $\mu$ m.

TABLE 1. Minimum (min), maximum (max), mean (med) and standard deviation (SD) values of length and width measurements of populations (n = 20) of genus *Ceratium* in freshwater ecosystems in semiarid region of Brazil.

RESERVOIR	LENGTH ( $\mu$ M)				WIDTH ( $\mu$ M)			
	Min	Max	Med	SD	Min	Max	Med	SD
Sobradinho	175	228	203	18.06	43	60	51	5.27
Rio de Contas	160	223	194	20.22	45	60	51	4.72
Moxotó	160	228	199	19.67	45	60	51	5.04
Paulo Afonso	160	228	199	19.67	45	60	51	5.04
Itaparica	160	228	200	20.63	43	60	51	5.3
Xingó	160	228	205	23.55	45	56	49	4.3

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## LITERATURE CITED

- Baldwin, D.S., J. Whittington and R. Oliver. 2003. Temporal variability of dissolved P speciation in a eutrophic reservoir – implications for predicating algal growth. *Water Research* 37: 4595-4598.
- Branco, S.M., W.C. Branco, H.A.S. Lima and M.T. Martins. 1963. Identificação e importância dos principais gêneros de águas de interesse para o tratamento de águas e esgoto. *Revista Departamento de Águas e Esgotos* 48-50: 1-59.
- Carty, S. 2003. Dinoflagellates; p. 685-714 In J.D. Wehr and R.G. Sheath (ed). *Freshwater Algae of North America*. San Diego. Elsevier Science.
- Ferrareze, M. and M.G. Nogueira. 2006. Phytoplankton assemblages and limnological characteristics in lotic systems of the Paranapanema basin (Southeast Brazil). *Acta Limnologica Brasiliensia* 18:389-405.
- Hickel, B. 1988. Morphology and life-cycle of *Ceratium rhomvroides* nov. sp. (Dinophyceae) from the lake Plußsee (Federal Republic). *Hydrobiologia* 161:49-54.
- Mac Donagh, M.E., M.A. Casco and M.C. Claps. 2005. Colonization of a neotropical reservoir (Cordoba, Argentina) by *Ceratium hirundinella* (O. F. Muller) Bergh. *Annales de Limnologie. Internacional Journal of Limnology* 41: 291–299.
- Mac Donagh, M.E., M.A. Casco and M.C. Claps. 2009. Plankton relationships under small water level fluctuations in a subtropical reservoir. *Aquatic Ecology* 43: 371-381.
- Pérez-Martínez, C. and P. Sánchez-Castillo. 2001. Temporal occurrence of *Ceratium hirundinella* in Spanish reservoirs. *Hydrobiologia* 452:101-107.
- Popovský, J. and L.A. Pfiester, 1990. *Dinophyceae (Dinoflagellida)*. Stuttgart: Süßwasserflora Von Mitteleuropa, 272 p.
- Padisák, J. 1985. Population dynamics of the freshwater dinoflagellate *Ceratium hirundinella* in the largest shallow lake of Central Europe, Lake Balaton, Hungary. *Freshwater Biology* 15:43-52.
- Santos-Wisniewski, M.J., L.C. Silva, I.C. Leone, R. Laudaes-Silva and O. Rocha. 2007. First Record of the occurrence of *Ceratium furcoides* (Levander) Langhans 1925, an invasive species in the hydroelectricity power plant Furnas reservoir, MG, Brazil. *Brazilian Journal of Biology* 67(4): 791-793.
- Matsumura-Tundisi, T., J.G. Tundisi, A.P. Luzia and R.M. Degani. 2010. Occurrence of *Ceratium furcoides* (Levander) Langhans 1925 bloom at the Billings Reservoir, São Paulo State, Brazil. *Brazilian Journal of Biology* 70(3): 825-829.
- Whittington, J., B. Sherman, D. Green and R.L. Oliver. 2000. Growth of *Ceratium hirundinella* in a subtropical Australian reservoir: the role of vertical migration. *Journal of Plankton Research* 22(6): 1025-1045.
- Wu, J.T. and J.W. Chou. 1998. Dinoflagellate associations in Feitsui Reservoir, *Botanical bulletin of Academia Sinica* 39: 137-145.

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